What is claimed is: ~~CLAIMS~~

(1) A semiconductor device connecting structure for connecting a semiconductor device onto a substrate, characterized by comprising a bonding layer interposed between said semiconductor device and said substrate to accomplish adhesion therebetween, ~~therein,~~ which includes a bonding material for adhering said semiconductor device onto said substrate and a space formed within said bonding material.

(2) A semiconductor device connecting structure as defined in claim 1, characterized in that said semiconductor device includes a plurality of bumps arranged in rows, and that said space is formed between said bump rows, outside said bump rows and between said bumps, or within at least one of the areas therein.

(3) A semiconductor device connecting structure as defined in claim 1 ~~or 2~~, characterized in that said space is constructed by placing a plurality of spaces closely to each other.

Sub A1 (4) A semiconductor device connecting structure as defined in any one of claims 1 to 3, characterized in that said bonding material is an anisotropic conductive film formed by dispersing conductive particles into a resin film.

~~(5) A semiconductor device connecting structure as defined in claim 1, characterized in that the rate of said space to said bonding material is 5% to 70%.~~

~~(6) A semiconductor device connecting structure as defined in claim 5, characterized in that the rate of said space to said bonding material is 10% to 30%.~~

(7) A semiconductor device connecting structure as defined in claim 1, characterized in that said bonding layer is made of an epoxy-based bonding material.

(8) A semiconductor device connecting structure for connecting a semiconductor device onto a substrate, characterized by comprising a bonding layer interposed between said semiconductor device and said substrate to

A accomplish adhesion ~~therein,~~ therebetween, which has an action to absorb deformation of said semiconductor device or said substrate.

Sub C3

(9) A semiconductor device connecting method for connecting a semiconductor device onto a substrate, characterized by comprising the steps of:

A

interposing a bonding layer between said semiconductor device and said substrate to accomplish adhesion therebetween; ~~therein;~~

joining said substrate and said semiconductor device to each other by pressing a pressurizing head, heated up to a high temperature, against said semiconductor device to pressurize and heat said bonding layer; and

forming a space within said bonding layer.

(10) A semiconductor device connecting method as defined in claim 9, characterized in that said bonding material is made of an epoxy-based bonding material.

Sub C4

(11) A liquid crystal display unit comprising:

a pair of liquid crystal holding substrates disposed in an opposed relation to each other with liquid crystal therebetween; ~~between;~~

A

a semiconductor device connected onto at least one of said liquid crystal holding substrates; and

a bonding layer interposed between said liquid crystal

A

holding substrate and said semiconductor device to accomplish adhesion ~~therein,~~ therebetween characterized in that

said bonding layer includes a bonding material for adhering said semiconductor device onto said liquid crystal holding substrate and a space formed within said bonding material.

(12) A liquid crystal display unit as defined in claim 11, characterized in that said semiconductor device includes a plurality of bumps arranged in rows, and that said space is formed between said bump rows, outside said bump rows and between said bumps or within at least one of the areas therein.

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A Sub B4

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(13) A liquid crystal display unit as defined in claim 11 ~~or 12~~, characterized in that said space is constructed by placing a plurality of spaces closely to each other.

Sub A27

(14) A liquid crystal display unit as defined in any one of claims 11 to 13, characterized in that said bonding material is an anisotropic conductive film formed by dispersing conductive particles into a resin film.

(15) A liquid crystal display unit as defined in claim 11, characterized in that the rate of said space to said bonding material is 5% to 70%.

Sub B6

(16) A liquid crystal display unit as defined in claim 15, characterized in that the rate of said space to said bonding material is 10% to 30%.

(17) An electronic apparatus having a plurality of semiconductor driving output terminals and a liquid crystal display unit connected to said semiconductor driving output terminals, characterized in that said liquid crystal display unit includes:

Sub C6

a pair of liquid crystal holding substrates disposed in an opposed relation to each other with liquid crystal therebetween; ~~between;~~

A

a semiconductor device connected onto at least one of said liquid crystal holding substrates; and

a bonding layer interposed between said liquid crystal holding substrate and said semiconductor device to accomplish adhesion therebetween, ~~therein.~~

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wherein said bonding layer includes a bonding material for adhering said semiconductor device onto said liquid

crystal holding substrate and a space formed within said bonding material.

add C7

Add D7

2. Claims

(1) A semiconductor-device-mounted structure, comprising: an insulating substrate; a wiring pattern area formed on the substrate, the wiring pattern area having a first portion and a second portion; a first electrically conductive substance provided on the first portion of the wiring pattern area; a gap provided above the second portion of the wiring pattern area so as to be located adjacent to the first electrically conductive substance; and a semiconductor device provided above the first electrically conductive substance and the gap.

(2) A semiconductor-device-mounted structure according to Claim 1, wherein only the gap exists between the semiconductor device and the gap provided above the second portion of the wiring pattern area.

(Embodiments)

Hereunder, a detailed description of embodiments of the present will be given with reference to the drawings.

Fig. 1 is a sectional view of a semiconductor-device-mounted structure in accordance with the present invention. Reference number 1 denotes a substrate, which is often formed of, for example, glass, ceramic, or resin. At least a surface of the substrate 1 is insulated. After applying a metallic material, such as a chromium-copper (Cr-Cu)

material or a titanium-palladium (Ti-Pd) material, to electrodes 6 of a semiconductor device 7, metallic protrusions 5 are formed. The metallic protrusions 5 are formed of a metallic material, such as gold (Au), copper (Cu), or solder. They are often formed to a thickness of a few micrometers to a few tens of micrometers by electroplating, sputtering, evaporation, or the like. Wiring patterns 2 are formed on the substrate 1 in correspondence with the positions of the metallic protrusions 5 formed on the semiconductor device 7. In general, the wiring patterns 2 are formed of a metal or a metal oxide. More specifically, they may be formed of, for example, nickel (Ni), copper (Cu), gold (Au), aluminum (Al), or indium tin oxide (ITO), and may be plated when necessary. The resistance may be decreased by placing the wiring patterns upon each other. An anisotropic, electrically conductive film 10 is provided in the form of a sheet or in liquid form, and is formed of a mixture of insulating resin B 4 and electrically conductive particles 9. Electrical conduction is achieved between the metallic protrusions 5 and the wiring patterns 2 through the electrically conductive particles 9. For the insulating resin B, styrene-butadiene rubber (SBR) resin, epoxy resin, acrylic resin, or the like, is often used. The electrically conductive particles used are often, for example, low

melting-point solder particles, nickel (Ni) particles, or plastic particles plated with nickel (Ni), gold (Au), or the like. The anisotropic, electrically conductive film 10 is thinner than the metallic protrusions 5, so that a gap 8 is formed between the wiring patterns 2 and the surface of the semiconductor device 7 on which a capacity element is formed. The gap 8 acts as an insulating layer. In order to achieve more reliable connection under a moisture-resistant environment, insulating resin A 3 is often applied to the entire surface around the semiconductor-device-mounted portion. For the insulating resin A, epoxy resin, acrylic resin, silicone resin, or the like, is often used. The type of resin used for the insulating resin A may be the same as that used for the insulating resin B. In general, the semiconductor device 7 and the substrate 1 are often bonded together with insulating resin B. Sometimes, the metallic protrusions 5 are formed above the wiring patterns 2 so as to oppose the electrodes 6 of the semiconductor device 7. The aforementioned electrically conductive particles may be placed between the electrodes 6 and the wiring patterns 2 so as to oppose them, by printing or the like.

Fig. 3 is a front view of the semiconductor-device-mounted structure of the present invention, as viewed from the substrate side. The wiring patterns 2, formed on the substrate 1, are electrically connected to the metallic

protrusions 5, formed on the semiconductor device 7, through the electrically conductive particles 9 contained in the anisotropic, electrically conductive film 10. The semiconductor device 7 and the substrate 1 are bonded together with insulating resin B 4 contained in the anisotropic, electrically conductive film 10. Since the anisotropic, electrically conductive film 10 is thinner than the metallic protrusions 5, the gap 8 is formed between the semiconductor device 7 and the substrate 1, so that the substrate 1 and the semiconductor device 7 are kept electrically insulated from each other. Also, the anisotropic, electrically conductive film 10 is not provided between the wiring patterns 2 disposed directly below the semiconductor device 7, so that they are kept electrically insulated from each other by the gap 8. Therefore, a short circuit does not occur between the semiconductor device and the wiring patterns or between the wiring patterns. Reference numeral 3 denotes the insulating resin A used to increase reliability under a moisture-resistant environment.

Fig. 4 is a sectional view of another embodiment of the semiconductor-device-mounted structure in accordance with the present invention. An anisotropic, electrically conductive film 10 is selectively provided between metallic protrusions 5, formed on electrodes 6 of a semiconductor device 7, and wiring patterns 2, formed on a substrate 1.

This causes a gap 8 that is wider than the gap 8 in the embodiment illustrated in Fig. 1 to be formed between the semiconductor device 7 and the wiring patterns 2, thereby further increasing insulation performance. The other structural features are similar to those illustrated in Fig. 1. The anisotropic, electrically conductive film 10 may be selectively placed directly below only the metallic protrusions 5.

A description will now be given of a method of mounting a semiconductor device to obtain the semiconductor-device-mounted structure of Fig. 1, with reference to Figs. 8(a) and 8(b). As shown in Fig. 8(a), an anisotropic, electrically conductive film 10 is temporarily applied to the surface of a semiconductor device at the side of metallic protrusions 5 formed on electrodes 6 of the semiconductor device 7. The anisotropic, electrically conductive film 10 is thinner than the metallic protrusions 5. Wiring patterns 2 on a substrate 1 and the metallic protrusions 5 are aligned at predetermined locations, after which the semiconductor device 7 and the substrate 1 are pressed against each other. When they are pressed against each other, insulating resin contained in the anisotropic, electrically conductive film is pushed out by the metallic protrusions 5 and the wiring patterns 2, and electrically conductive particles 9 come into direct contact with the

metallic protrusions 5 and the wiring patterns 2, whereby electrical conduction occurs. In the state shown in Fig. 8(b), or at the same time that the pressing is carried out, energy, such as heat energy or light energy, is added in order to cause the insulating resin contained in the anisotropic, electrically conductive film to exhibit its bonding properties. Thereafter, the bonding is completed, with the gap 8 being maintained between the semiconductor device and the substrate.

A description will now be given of a method of mounting a semiconductor device to obtain the semiconductor-device-mounted structure of Fig. 2, with reference to Figs. 9(a) and 9(b). As shown in Fig. 9(a), an anisotropic, electrically conductive film 10 is selectively placed on metallic protrusions 5 formed on electrodes 6 of a semiconductor device 7. Methods of placement include a method in which an anisotropic, electrically conductive film that has been previously pushed out from a die and formed in correspondence with the metallic protrusions is aligned with the metallic protrusions 5 and temporarily adhered thereto by pressing; and a method in which an anisotropic, electrically conductive film in liquid form is adhered to the metallic protrusions 5 so as to oppose them, by, for example, a printing operation or a transferring operation. Similarly to the method illustrated in Figs. 8(a) and 8(b),

after the placement of the anisotropic, electrically conductive film, wiring patterns 2, formed on the substrate 1, and the metallic protrusions 5, formed on the semiconductor device 7, are aligned and then press-bonded together. When this is done, as shown in Fig. 9(b), only gap 8 exists between the semiconductor device 7 and the wiring patterns 2 formed on the portion of the substrate 1 directly below an active surface of the semiconductor device 7.

FIG. 1

1 Substrate

2 Wiring pattern

3 Insulating resin A

4 Insulating resin B

5 Metallic protrusion

6 Electrode

7 Semiconductor device

8 Gap

9 Electrically conductive particles

10 Anisotropic, electrically conductive film

FIG. 3

To connection circuit

7 Semiconductor device

8 Gap

9 Electrically conductive particles

10 Anisotropic, electrically conductive film

FIG. 4

1 Substrate

2 Wiring pattern

3 Insulating resin A

4 Insulating resin B

5 Metallic protrusion

6 Electrode

7 Semiconductor device

8 Gap

9 Electrically conductive particles

10 Anisotropic, electrically conductive film

FIG. 8

1 Substrate

2 Wiring pattern

7 Semiconductor device

8 Gap

9 Electrically conductive particles

10 Anisotropic, electrically conductive film

FIG. 9

1 Substrate

2 Wiring pattern

7 Semiconductor device

8 Gap

9 Electrically conductive particles

10 Anisotropic, electrically conductive particles